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EXPERIMENTAL INVESTIGATIONS ON EFFECT OF WELD PARAMETERS IN TIG WELDING OF ALUMINIUM

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ABSTRACT

Process parameters play an important role in the weld bead properties. This paper aims to study the influence of various parameters like Voltage, Current, gas flow rate on the weld obtained.TIG welding of aluminum 6063 and 7075 was performed based on the Taguchi design for the experiments. The defects and mechanical properties for the weld bead are studied for all the specimens. From the results, it is observed that voltage is the most influencing factor.

KEYWORDS: Weld Bead, TIG Welding, Mechanical Properties & Taguchi Design

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Original Article

INTRODUCTION

Welding of aluminum is challenging as it is difficult to get a strong weld bead.

Luijendijk studied the influence of asymmetric weld and the behaviour of melting in the weld bead generated from welding of aluminium alloy plates of varied thickness. An optimal solution for the materials with different thermal properties was derived,

M. Ishaket et. al., performed MIG welding for AA 7075. mechanical properties were studied by using various filler metals. the efficiency of the weld was optimized

K Srinivas et al, have carried out TIG welding for AA 6063. Effect of the current on the mechanical properties was studied. Welding was carried out using pulsed A.C current. the current had adversely affected the bead formation beyond a permissible value.

L.Suresh et al, studied the influence of weld flux properties on the weld bead geometry.

In this work, L9 taguchi orthogonal array was designed to perform welding of Aluminium plates. A filler rod electrode was used to perform weld on both sides of weld plates. Penetration test, Tensile test and hardness test are performed on the weld bead.

METHODOLOGY

The methodology involves the problem identification and solving, experimental investigations, preparation of work pieces for experimentation, discuss desired results and modifications in the experiment, get data collection and analysis of data obtained

The work piece consists of 2 plates of aluminium of different grades that have been welded. The grades welded are as follows: 6063(T6) and 7075(T6).

Aluminium 7075(T6) is a high-strength alloy that possesses good stress-corrosion cracking resistance. Aluminium 6063(T6) is a medium strength alloy commonly referred to as an architectural alloy.

Two grades of Aluminium have been considered for carrying out the experiment. The two grades of Aluminium are as follows: Aluminium 6063(T6) and Aluminium 7075(T6). Welding has been done joining two different grades by welding it both sides.

Aluminium plate dimensions:

- Number of plates = 9
- Length = 31.5cm
- Breadth = 15cm

Figure 1: Aluminium Plate.

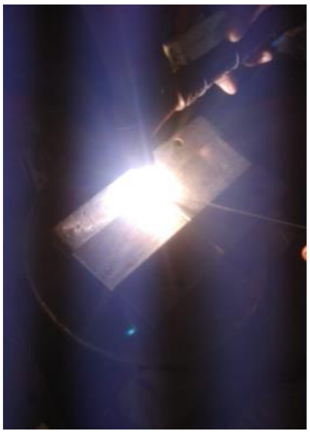

Figure 2: Aluminium Plates undergoing Welding.

Figure 3: Aluminium Plates after Welding.

A 5mm thick sheet of Aluminium of two different grades namely Aluminium 6063(T6) and Aluminium 7075 (T6) has been used for carrying out the experiment as shown in fig 1. The sheet metal of Aluminium 6063 (T6) is of dimensions 31.5cm x 15cm. Similarly, the sheet metal of Aluminium 7075 (T6) is of dimensions 31.5cm x 15cm. These sheet metals have been cut into nine pieces each from the two sheets and have been welded together.

The parameters selected for carrying out the experiment are gas flow rate and current. Three different values of both the parameters are selected resulting in nine combinations of welding parameters which are shown in table 1.

Table 1: Weld Parameters Considered

Specimen Number	Corresponding Current (Ampere)	Gas Flow Rate (Litre/Minute)	Voltage (V)
1.	130	15	50
2.	130	17	55
3.	130	19	60
4.	150	15	55
5.	150	17	60
6.	150	19	50
7.	170	15	60
8.	170	17	55
9.	170	19	50

The welding is carried out by using the values in table 2. The TIG welding is shown in Figure 2. and Figure 3.

Liquid Penetration Test

Liquid penetrant test was performed by using a Liquid dye and then by applying a developer.

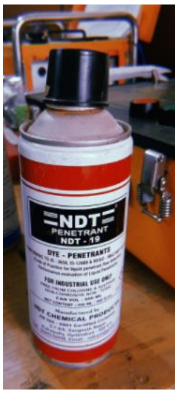

Figure 4: Penetrant

Figure 5: Cleaner /Remover.

Figure 6: Applying the Penetrant.

Figure 7: Brinell's Hardness Machine.

Precleaning has been done with lint free cloth and cleaner. The penetrant type is Solvent Removable. For penetrant application, a spray can is used. The penetrant, cleaner is shown in fig 4, fig 5 and fig 6. Shows the application of the penetrant.

Cleaning has been done with lint free cloth. For developer applications, a spray has been used. Dwell time is 20 minutes. After the dwell time, cracks have been observed.

Brinell's Hardness Test

The Brinell hardness test machine as shown in fig 7 uses an indenter made of hardened steel which is pushed into the material under a specific force.

Tensile Test

Tensile specimens were cut from the work piece according to the ASTM standards. the tensile test is carried out using the specimen shown in fig 8

Figure 8: Prepared Tensile Specimen.

RESULTS

The results obtained throughout the experimental research analysis of parameters like gas flow rate and current with respect to the tests namely liquid penetration test, brinell's hardness test as well as ultimate tensile strength

The observations made in the liquid penetration test are represented in table 2.

Table 2: Observation of Weldments in Liquid Penetration Test

Specimen Number	Current (amps)	Gas Flow Rate (Litres/min)	Voltage (Volts)	Observation
1	130	15	50	Incomplete penetration
2	130	17	55	Incomplete penetration
3	130	19	60	Pin holes
4	150	15	55	Incomplete penetration
5	150	17	60	Pin holes and incomplete penetration
6	150	19	50	Incomplete penetration
7	170	15	60	Incomplete penetration
8	170	17	55	Incomplete penetration
9	170	19	50	Incomplete penetration

It has been observed that specimen 3with current 130 amperes, gas flow rate 19 litres/min and voltage 60 volts and specimen 5 with current 150 amperes, gas flow rate 17 litres/min and voltage 55 volts have pin holes. Incomplete penetration has been observed in the rest of the specimens.

Incomplete penetration is due to the low current level for the size of root face and weld pool bridging the root without achieving adequate penetration. It can be understood that with the increase in the value of current, more are the chances of visibility of cracks and pin holes.

Brinell’s hardness test results are represented in the table 4

Type of hardness: HBW

Indentor: 5mm

Load applied: 250Kgf

Table 4: Observation values in HBW 5mm/250 in Brinell's Hardness Test

Specimen Number	Current (Amperes)	Gas Flow Rate (Litres/min)	Voltage (Volts)	I1	I2	I3	Average
1	130	15	50	46.7	47.1	47.5	47.10
2	130	17	55	47.5	47.5	47.9	47.63
3	130	19	60	46.7	45.9	46.3	46.30
4	150	15	55	44.4	43.7	43.7	43.93
5	150	17	60	48.3	48.3	47.5	48.03
6	150	19	50	47.5	47.5	47.1	47.37
7	170	15	60	47.1	47.1	47.9	47.37
8	170	17	55	47.5	47.1	46.7	47.10
9	170	19	50	47.5	44.8	46.7	46.33

To express this hardness values with tungsten ball HBW is used instead of just HB. So the only difference between HB & HBW is the material of the ball used in Indenter. Higher hardness value has been found in specimen 5 and lower hardness value has been found in specimen 4.

Observations of weldments in Tensile Test are shown in table 5.

Table 5: Tensile Test

Specimen Number	Specimen width (cm)	Specimen Thickness (cm)	Original Gauge Length (cm)	Final Gauge Length (cm)	Yield Load (KN)	Yield Stress (Mpa)	Ultimate Load (KN)	Ultimate Tensile Strength (Mpa)	Elongation (%)
1	21	0.5	5	5.241	7.800	62.605	9.780	78.497	4.820
2	21	0.5	5	5.196	2.040	16.907	6.860	56.854	3.920
3	21	0.5	5	5.201	6.300	51.290	7.740	63.014	4.020
4	21	0.5	5	5.265	8.650	69.651	10.250	82.535	5.300
5	21	0.5	5	5.245	5.840	46.338	7.480	59.351	4.900
6	21	0.5	5	5.206	8.260	67.385	9.420	76.848	4.120
7	21	0.5	5	5.281	6.160	50.422	6.820	55.824	5.620
8	21	0.5	5	5.275	9.320	76.796	11.740	96.737	5.500
9	21	0.5	5	5.284	6.720	53.636	9.420	75.186	5.680

It can be observed that with an increase in the value of current (in amperes), after applying a certain amount of load to various weldments, yield stress also increases. So, it can be understood that yield stress increases with an increase in gas flow rate too.

CONCLUSIONS

From the experiment of TIG welding of an aluminium plate (grade 6063 and 7075), the following conclusions can be made:

From the results, it is observed that the most influencing parameter is Voltage and the least influencing parameter is gas flow rate.

The ultimate tensile strength of 96.737MPa (Max) is obtained when the parameters were set at the following values Current= 170 Amps, Gas flow rate= 17 litre/minute, Voltage= 50 V

It is observed that with increase in current the UTS is increasing and with increase in voltage the UTS is

decreasing.

The variation in gas flow rate is only showing a marginal variation on the UTS.

A similar effect is observed on the hardness.

In liquid penetration test, high current level should be considered for the root face for complete penetration else incomplete penetration could be observed.

In liquid penetration test, pinhole formation can be reduced by carefully cleaning the surface of the weld joint prior to welding and by reducing the speed of welding.

With an increase in the value of current (taken in amperes), cracks have been found. Therefore, to avoid the visibility of cracks, the value of current should be decreased.

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